Air Quality Monitoring:

Bonanza Area

February 2009 **Final Report**

Overview

A short monitoring survey was conducted in the Bonanza area, northwest of Grande Prairie near the BC border, to evaluate the quality of air. Landowners are concerned about the impact of oil and gas activity on air quality in the area. As a result, this report focuses on pollutants typically associated with such activities. The survey was conducted using Alberta Environment's Mobile Air Quality Monitoring Laboratory. Samples were collected on two days in February 2009.

Hydrocarbon concentrations at a number of sites were comparable to concentrations measured at background sites. The two exceptions were samples collected near an oil and gas production site (a battery) operated by Bonavista Energy and the Newalta Gordondale oilfield waste treatment facility. Samples at these sites are likely impacted by fugitive emissions from nearby operations.

The one-hour average hydrogen sulphide (H_2S) concentration measured downwind of the Bonavista battery exceeded Alberta's ambient air quality objective. For part of the monitoring period, the glycol dehydrator still's incinerator was not operating and continuous odours were noted. H_2S concentrations at most other sites were below detection or close to detection limit.

Concentrations of oxides of nitrogen (NO_x) and particulate matter (PM) measured during this survey were generally low as would be expected for rural sites. One-hour average nitrogen dioxide (NO_2) concentrations did not exceed the one-hour air quality objective. Similarly, one-hour average $PM_{2.5}$ (particulate matter with aerodynamic diameter less than 2.5 micrometer) concentrations did not exceed the one-hour provincial guideline.

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1 Introduction

Alberta Environment regularly conducts air quality surveys as part of its monitoring program. For the current survey, the department's Mobile Air Monitoring Laboratory (MAML) was used. The MAML is equipped to measure a suite of pollutants typically associated with industrial and urban emissions. Measurements performed by instruments onboard the MAML provide a "snap shot" of the air quality in time and space. One-hour average concentrations from these measurements are compared to Alberta's Ambient Air Quality Objectives (AAAQO) and guidelines (AAAQG). Further explanation of air quality objectives is provided in Appendix B.

Landowners in the Bonanza area have expressed concern regarding the quality of air and how it is affected by nearby oil and gas activities. This report focuses on concentrations of pollutants associated with such activities, namely hydrocarbons, sulphur compounds, oxides of nitrogen and particulate matter. Data for the current study were collected on two days in February 2009. Every effort was made to monitor at a number of different locations and sample air representative of the area. However, meteorology at the time of monitoring and topography of the area limited the available monitoring sites.

To facilitate comparison with provincial air quality objectives and guidelines, data are collected for at least one-hour and an average for this period is reported. Due to difficulties in finding appropriate monitoring locations, only eight one-hour averages were available for comparison. However, averages for shorter sample period are also listed in the appendix, although these values may not be compared to AAAQOs or AAAQGs.

2 Monitoring method and location

The department's Mobile Air Monitoring Laboratory (MAML) is equipped to measure ammonia, carbon monoxide, hydrocarbons, oxides of nitrogen, ozone, particulate matter, reduced sulphur compounds and sulphur dioxide simultaneously. A description of the MAML and the detection limit of the various instruments onboard are given in Appendix B.

Figure 1 indicates the sampling locations. Table 1 provides a description of these sites. At least one hour of data were collected at **Sites 1**,**2**,**3**,**4**, and **8**. The results section discusses the findings at these sites. **Site 1** located in Bonanza was intended to sample air quality within the community. **Sites 2**, **4** and **8** were downwind of oil and gas activity. **Site 3**, located on the Alberta/British Columbia border, was a background site. At **Sites 5**, **6**, and **7** samples were collected for less than an hour, these data will not be discussed in the results but are presented in Appendix A Table A1.

Table 1: Air quality monitoring sites

Site Number	Description
1	Community of Bonanza
2	Across the ravine from Spectra Energy Pouce Coupe Sour Gas plant
3	Alberta /British Colombia border
4	Battery operated by Bonavista Energy
8	Newalta Gordondale oil field waste treatment facility
5	*AltaGas Pouce Coupe*
6	*ConocoPhilips Battery*
7	*Burlington Resources*

Figure 1: Map of sample sites. The base map for this figure was obtained from *The Atlas of Canada*[1].

[1] http://atlas.nrcan.gc.ca/site/english/maps/topo/map

3 Results and Discussion

The following sections will focus on pollutants relevant to the study, namely one-hour average concentrations of oxides of nitrogen, sulphur compounds, hydrocarbon and particulate matter concentrations. Concentrations for all other monitored pollutants are presented in Table A1 in the appendix. At two of the five monitoring locations (**Sites 1** and **2**) more than one one-hour average concentration was available. In these cases, a median one-hour average concentration is used for discussion. The median concentration is a common way of representing the central value for environmental data. Further justifications for using the median concentration are presented in Appendix B.

3.1 Oxides of Nitrogen (NO and NO_2)

Nitrogen dioxide (NO_2) and nitric oxide (NO) are known collectively as oxides of nitrogen (NO_x). In Alberta, transportation (automobiles, locomotives and aircraft) is the major source of NO_x. Other major sources include the oil and gas industries and power plants. Alberta has a one-hour ambient air quality objective of 0.212 ppb for NO_2. NO_2 along with volatile organic compounds (VOCs) play a major role in the formation of ground level ozone. Both NO and NO_2 may be emitted by high temperature combustion processes. NO is readily oxidized in the atmosphere into NO_2.

NO_x for the study was generally low. One-hour average NO_2 concentrations were well below Alberta's air quality objective of 0.212 ppm. The median one-hour average NO_2 concentration for the entire study was 0.007 ppm compared to 0.030 and 0.032 ppm measured[2] at Edmonton and Calgary Central stations. NO_2 concentrations for other studies are presented in Table A4 in Appendix A. Figure 2 illustrates that the lowest NO_x concentrations were measured at the background site (**Site 3**) and in the vicinity of Bonavista Battery (**Site 4**), where no significant combustion sources were operating. One-hour average NO_x concentrations at these two sites were 0.010 ppm. The highest one-hour average NO_x concentration measured for the study was 0.028 ppm at **Site 8** (Newalta). This sample also contained a higher ratio of NO implying some impact from the exhaust of a vacuum truck operating nearby.

[2] Median concentrations for sample collected during February 2009

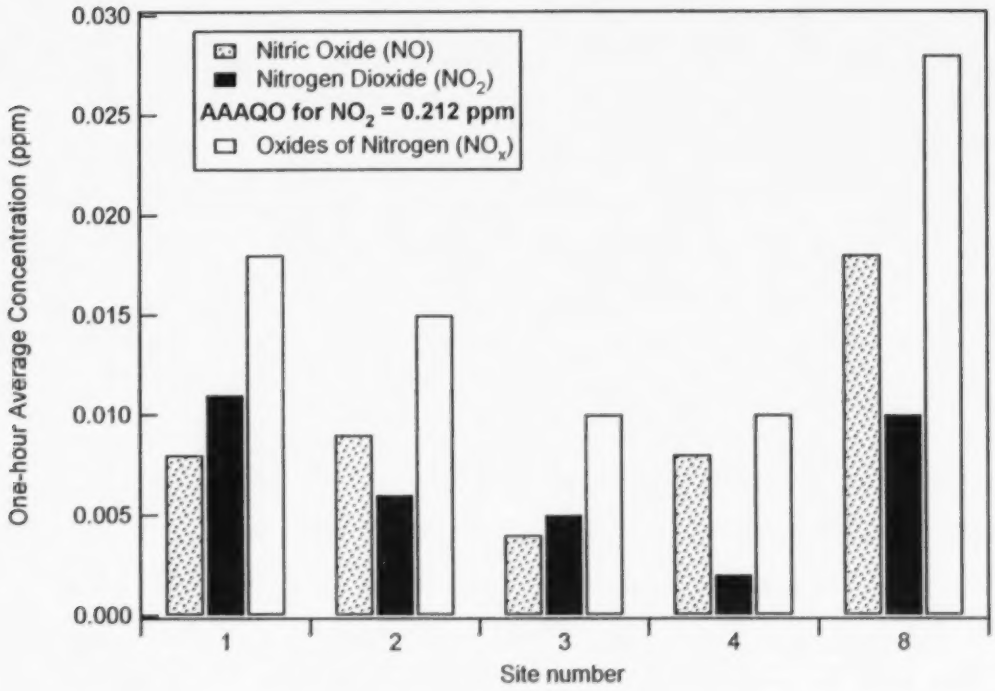

Figure 2: One-hour average NO_x concentrations. At Sites 1 and 2 multiple one-hour average data points were available thus median one-hour averages are presented.

3.2 Hydrocarbons

The term "total hydrocarbons" (THC) refers to a broad family of chemicals that contain carbon and hydrogen atoms. Methane (CH_4) is the most common hydrocarbon in the earth's atmosphere. As a result, for most rural measurements around Alberta, concentrations of THC and CH_4 are equivalent, and the typical background concentration is about 2 ppm. Reactive hydrocarbons (RHC) form the remaining fraction of THC. The major sources of hydrocarbons include vegetation, vehicle emissions, gasoline storage tanks, petroleum and chemical industries and fugitive emissions such as leaks and evaporation of solvents.

Hydrocarbon concentration at the background site (**Site 3**) and the site near Spectra (**Site 2**) were comparable to background concentrations around Alberta (~2 ppm). At these sites methane (CH_4) formed greater than 90% of the measured THC concentrations (Figure 3). THC concentration within Bonanza was only marginally higher, with a median one-hour average of 2.5 ppm. The median one-hour average concentrations for methane and RHC at **Site 1** (Bonanza) were, 2.2 and 0.4 ppm, respectively. THC concentrations at **Site 4** (Bonavista

Battery) and **Site 8** (Newalta) were notably higher with one-hour average concentrations of 5.7 and 6.5 ppm, respectively. At the Bonavista battery, methane formed the larger fraction of THC with a one-hour average concentration of 4.2 ppm. For part of the monitoring period, the glycol dehydrator still's incinerator was not operating. A glycol dehydrator still column vent can be a source of hydrocarbons including methane[3]. At **Site 8** (Newalta), RHC contributed more to THC with a one-hour average concentration of 4.4 ppm (68% of THC). At the time of sampling a vacuum truck was unloading near **Site 8**. Fugitive emissions from the truck are a possible source of hydrocarbons at **Site 8**.

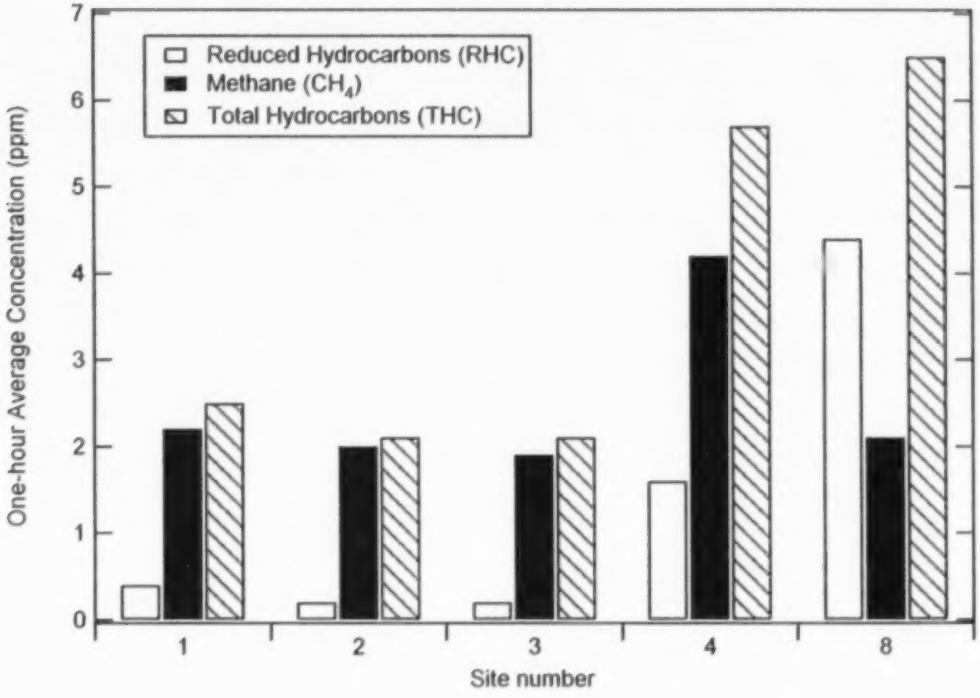

Figure 3: One-hour average hydrocarbon concentrations. At Sites 1 and 2 multiple one-hour average data points were available thus median one-hour averages are presented.

[3] Best management practices for the control of benzene emissions from glycol dehydrators. A document prepared by the working group on Benzene from glycol dehydrators, a multi stakeholder group chaired by Environment Canada.

3.3 Total Reduced Sulphur (TRS) Including Hydrogen Sulphide (H_2S)

Total reduced sulphur (TRS) includes hydrogen sulphide (H_2S), mercaptans, dimethyl sulphide, dimethyl disulphide, and other sulphur compounds. The major industrial sources of H_2S and TRS are petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, oil sands plants, sewage treatment facilities, pulp and paper plants that use the Kraft pulping process, and animal feedlots. Natural sources of H_2S include sulphur hot springs, sloughs, swamps and lakes. Sulphur dioxide is not a reduced sulphur; concentrations of SO_2 are found in Appendix A Table A1.

Concentrations of reduced sulphurs were below detection or very close to the instrument detection limit at **Sites 1-3.** The one-hour average H_2S concentration at **Site 4** was above AAAQO of 0.010 ppm. TRS concentrations measured at **Site 4** were deemed invalid due to interference. Elevated H_2S concentrations at **Site 4** are likely due to emissions form nearby oil and gas activity. For a portion of the monitoring time, the glycol dehydrator still's incinerator was not operating and continuous odours were noted (Table A3). Similarly at **Site 8** strong odour associated with oil and gas activity was noted and confirmed with the observation of elevated reduced sulphur concentrations. The relative difference in the concentrations measured at **Sites 4** and **8** when compared to the other sites is illustrated in Figure 4.

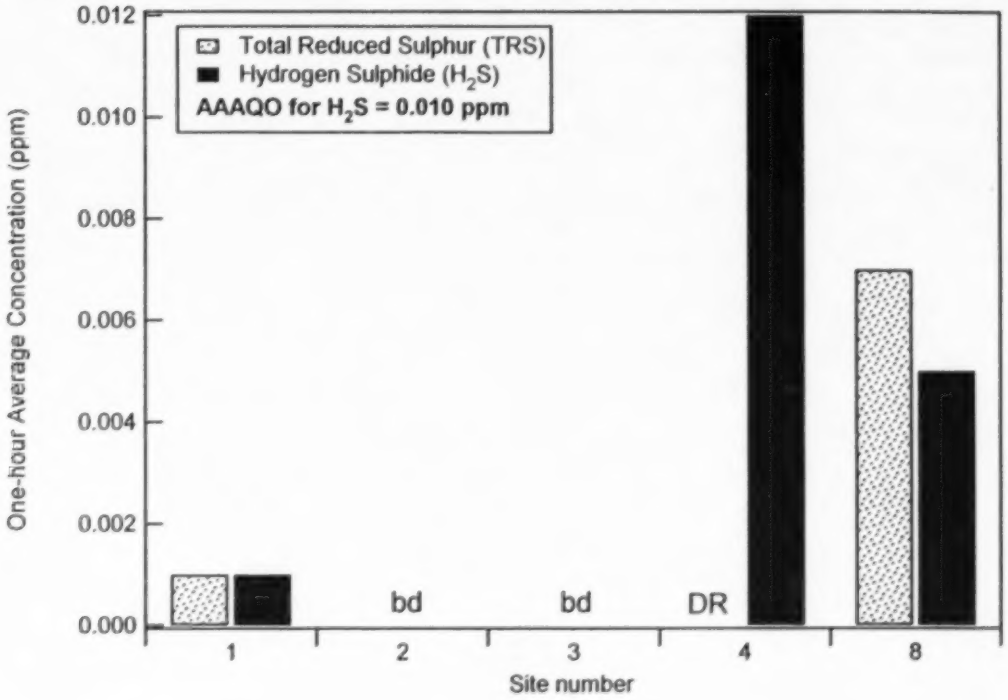

Figure 4: One-hour average reduced sulphur concentrations. At Sites 1 and 2 multiple one-hour average data points were available thus median one-hour averages are presented. bd indicates data below detection limit. DR indicates invalid data removed.

3.4 Particulate Matter (PM_{10}, $PM_{2.5}$ and PM_1)

Inhalable particulates are particulate matter less than 10 micrometres (μm) in aerodynamic diameter (PM_{10}). These particles can be inhaled into the nose and throat. Sources of PM_{10} include soil dust, road dust, agricultural dust (e.g., harvest), smoke from forest fires and wood burning, vehicle exhaust and industrial emissions. Respirable particulates are those particulate matter less than 2.5 μm ($PM_{2.5}$) in aerodynamic diameter. In addition to PM_{10} and $PM_{2.5}$, PM_1 (particles less than 1 μm in aerodynamic diameter) were also measured. $PM_{2.5}$ and PM_1 may form in the atmosphere and/or arise from combustion sources such as vehicle exhaust emissions, industrial emissions and wood burning.

Alberta has a one-hour air quality guideline (AAAQG) of 80 $\mu g/m^3$ for $PM_{2.5}$; concentrations measured during the current study did not exceed this value. Figure 5 presents one-hour average particulate matter concentrations. Particle concentrations at the background site (**Site 3**) were affected by road dust (PM_1 formed 8% of PM_{10}); concentrations measured at

this site are presented in Table A1, but are removed from Figure 5. One-hour average concentrations measured during this study are comparable to those measured at most other MAML survey locations (Table A4). Particle concentrations in Bonanza (**Site 1**) were most likely due to local activities. A notable fraction (~50%) of the PM_{10} consisted of submicron particles (PM_1). The median one-hour average concentrations at **Site 2** (downwind of Spectra) were similar to those measured at **Site 1** and may be a reflection of general concentration in the area.

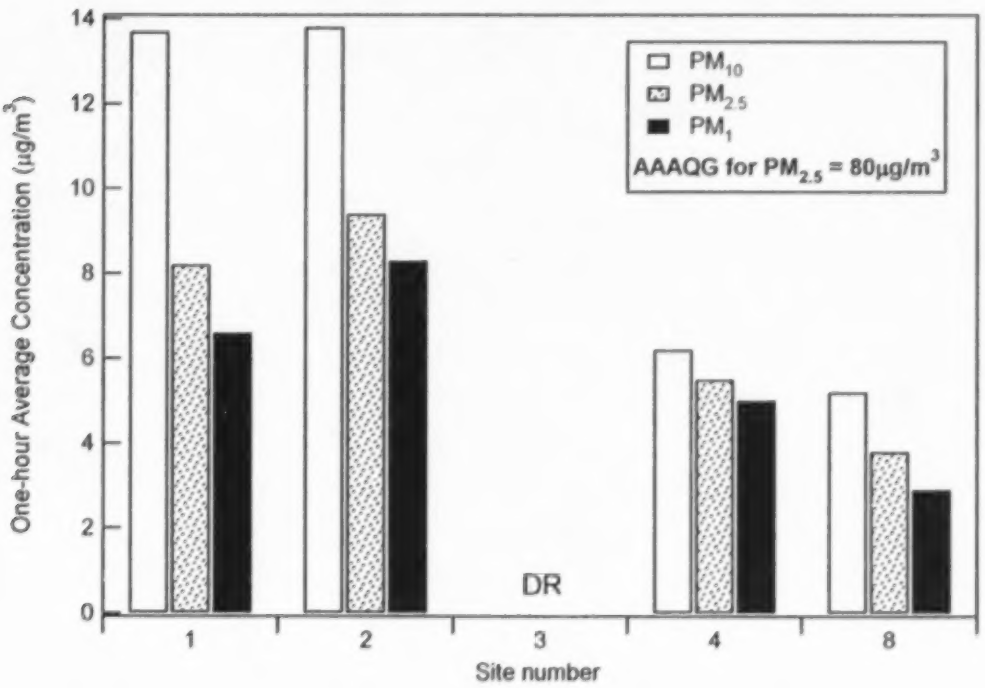

Figure 5: One-hour average reduced sulphur concentrations. At Sites 1 and 2 multiple one-hour average data points were available thus median one-hour averages are presented. Data collected at Site 3 were affected by road dust from traffic on rural grid roads. These data were removed (DR).

Appendix A

Table A 1: Ambient concentration for gaseous parameters at monitoring sites

Date	Site #	Sample Times	CO	O_3	THC	CH_4	RHC	SO_2	NO	NO_2	NO_x	NH_3	TRS	H_2S
			PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM
10-Feb	1	10:42 to 11:42	0.1	0.025	2.4	2.1	0.3	0.002	0.005	0.007	0.011	bd	bd	0.001
10-Feb	2	12:11 to 13:11	0.1	0.023	2.1	2.0	0.2	0.002	0.010	0.010	0.019	bd	bd	0.001
10-Feb	2	13:11 to 14:11	0.3	0.025	2.3	2.1	0.2	0.001	0.009	0.006	0.015	0.002	bd	0.001
10-Feb	2	14:11 to 15:11	0.2	0.028	2.1	2.0	0.2	0.002	0.005	0.006	0.010	bd	bd	0.001
10-Feb	3	16:32 to 17:32	0.2	0.027	2.1	1.9	0.2	0.001	0.004	0.005	0.010	bd	bd	0.001
11-Feb	1	09:10 to 10:11	0.3	0.014	2.6	2.2	0.4	bd	0.010	0.014	0.025	bd	0.001	0.001
11-Feb	1	*13:52 to 14:23*[a]	0.2	0.023	2.1	1.9	0.2	0.001	0.005	0.007	0.013	0.002	0.001	bd
11-Feb	4	*11:04 to 11:34*[b]	0.2	0.024	3.3	2.6	0.7	bd	0.004	0.002	0.006	bd	0.002	0.003
11-Feb	4	*11:34 to 12:04*[b]	0.2	0.023	5.4	4.1	1.4	0.001	0.008	0.002	0.011	bd	0.007	0.012
11-Feb	4	*12:04 to 12:32*[b]	0.2	0.023	6.6	4.7	1.8	0.001	0.012	0.001	0.010	0.002	DR	0.012
11-Feb	4	11:24 to 12:24	0.2	0.023	5.7	4.2	1.6	0.001	0.008	0.002	0.010	bd	DR	0.012
11-Feb	5	*12:59 to 13:12*[c]	0.3	0.022	2.4	2.0	0.4	0.001	0.009	0.004	0.012	0.001	bd	0.001
11-Feb	5	*13:20 to 13:32*[c]	0.2	0.027	4.2	2.8	1.5	0.002	0.009	0.006	0.014	bd	0.001	0.001
11-Feb	6	*14:53 to 15:15*[d]	0.2	0.030	1.6	1.6	bd	0.001	0.001	0.003	0.004	bd	0.001	0.001
11-Feb	7	*15:48 to 15:54*[d]	0.3	0.028	2.0	1.9	0.1	0.001	0.006	0.003	0.008	0.003	bd	0.001
11-Feb	8	17:04 to 18:04	0.2	0.025	6.5	2.1	4.4	bd	0.018	0.010	0.028	0.003	0.007	0.005

Notes:

bd – below detection limit **DR** – Data removed (data invalid due to interference) **ppm** - parts per million

a – located downwind of activity yet measured concentrations were low
b – half hour interval averaging done to highlight changes in concentration
c – trying to find suitable downwind location (see notes in Table A3)
d – no activity on site

Table A 2: Ambient concentration for particulate matter at monitoring sites

Date	Site #	Sample Times	PAH	PM_{10}	$PM_{2.5}$	PM_1
			ng/m^3	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$
10-Feb	1	10:42 to 11:42	bd	14	8	7
10-Feb	2	12:11 to 13:11	bd	17	13	12
10-Feb	2	13:11 to 14:11	bd	14	9	8
10-Feb	2	14:11 to 15:11	bd	8	6	5
10-Feb	3*	16:32 to 17:32	bd	97	18	8
11-Feb	1	09:10 to 10:11	bd	14	8	6
11-Feb	1	*13:52 to 14:23*[a]	3	50	12	6
11-Feb	4	*11:04 to 11:34*[b]	bd	6	6	5
11-Feb	4	*11:34 to 12:04*[b]	bd	6	6	5
11-Feb	4	*12:04 to 12:32*[b]	bd	6	5	5
11-Feb	4	11:24 to 12:24	bd	6	6	5
11-Feb	5	*12:59 to 13:12*[c]	bd	7	6	5
11-Feb	5	*13:20 to 13:32*[c]	bd	5	5	5
11-Feb	6	*14:53 to 15:15*[d]	bd	4	4	4
11-Feb	7	*15:48 to 15:54*[d]	bd	5	5	4
11-Feb	8	17:04 to 18:04	6	5	4	3

Notes:

bd – below detection limit ***** - likely effected by road dust

ng/m^3 = nanograms per cubic meter **$\mu g/m^3$** = micrograms per cubic meter

a – located downwind of activity yet measured concentrations were low
b – half hour interval averaging done to highlight changes in concentration
c – trying to find suitable downwind location (see notes in Table A3)
d – no activity on site

Table A 3: Meteorological data at sampling sites and MAML operator's comments

Date	Site #	Sample Times	Comments	Temp	RH	WSP	WDR
				° C	%	KPH	DEG
10-Feb	1	10:42 to 11:42		-10.3	69.5	4.1	207
10-Feb	2	12:11 to 13:11	no odors downwind across valley from Spectra gas plant	-8.0	65.1	5.7	187
10-Feb	2	13:11 to 14:11		-5.7	59.7	4.1	126
10-Feb	2	14:11 to 15:11		-5.3	60.6	5.8	190
10-Feb	3	16:32 to 17:32	Particulate readings likely from suspended road dust	-7.0	66.7	1.8	87
11-Feb	1	09:10 to 10:11		-14.0	83.2	2.7	134
11-Feb	1	*13:52 to 14:23*[a]	no odours	-8.2	69.0	6.2	242
11-Feb	4	*11:04 to 11:34*[b]	operator on site attempting repairs	-14.8	78.2	5.4	261
11-Feb	4	*11:34 to 12:04*[b]	continuous odours	-15.2	82.0	9.1	265
11-Feb	4	*12:04 to 12:32*[b]	12:25 incinerator relit	-14.5	82.1	9.7	261
11-Feb	4	11:24 to 12:24		-14.9	81.6	8.6	263
11-Feb	5	*12:59 to 13:12*[c]	~ 2km NE of Alta Gas plant	-10.0	74.3	5.7	243
11-Feb	5	*13:20 to 13:32*[c]	~200 meters SE of plant	-8.3	71.8	14.1	312
11-Feb	6	*14:53 to 15:15*[d]	Oil battery non-operational	-8.5	70.5	16.8	120
11-Feb	7	*15:48 to 15:54*[d]	Oil battery non-operational	-8.8	71.1	10.8	107
11-Feb	8	17:04 to 18:04	Strong odour	-10.7	78.7	10.6	305

Notes:

Temp - Temperature in degrees centigrade **RH** – Relative humidity in percentage **WSP KPH** – Wind speed in Km/hr
WDR DEG – Wind direction in degrees

a – located downwind of activity yet measured concentrations were low
b – half hour interval averaging done to highlight changes in concentration
c – trying to find suitable downwind location (see notes in Table A3)
d – no activity on site

Table A 4: Median one-hour average concentrations measured at selected MAML surveys and permanent monitoring stations.

Station or Survey Type	Air Quality Station or Survey Name	Monitoring Period	CO ppm	O_3 ppm	THC ppm	CH_4 ppm	RHC ppm	SO_2 ppm	NO_2 ppm	NH_3 ppm	TRS ppm	H_2S ppm	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	PM_1 µg/m³	PAH ng/m³
mobile	Bonanza (Current)	February 2009	0.2	0.025	2.4	2.1	0.3	0.001	0.007	bd	bd	0.001	14	8	7	bd
	Wabamun	Nov 2004 - Oct 2007	0.2	0.032	2.0	2.0	bd	0.003	0.005	0.001	bd	bd	12	3	4*	bd
	Fort Saskatchewan and Redwater Area	Jan 2006 - Nov 2007	0.2	0.030	1.9	1.9	bd	0.003	0.004	0.003	bd	bd	10	3	7*	bd
	Slave Lake	Dec 2005 -Mar 2006	0.2	0.003	2.4	2.4	bd	0.001	0.012	bd	0.001	bd	13	5	n/a	8
	Calder Yards Edmonton	Mar 2005	0.7	0.010	2.7	2.5	0.3	0.002	0.033	0.008	0.001	0.001	28	4	n/a	20
	Tolko High Prairie	Dec 2005 -Mar 2006	0.2	0.018	2.0	1.9	bd	0.001	0.005	bd	0.001	bd	12	3	n/a	bd
	Caroline	Oct 05 & Jan, May, Jun 06	0.2	0.038	1.8	1.8	bd	0.002	0.004	0.003	0.001	0.001	49	6	n/a	bd
	Girouxville	Fall 2004, spring 2005, 2006	0.3	0.028	2.1	2.1	bd	0.001	0.001	0.013	0.002	0.001	15	2	n/a	bd
	Whitecourt	Sep. 6 - 7, 2005	0.2	0.027	2.1	2.1	bd	0.001	0.002	0.084	0.001	0.001	16	2	n/a	bd
Permanent Continuous Monitoring Stations																
urban	Calgary Central	February 2009	0.4	0.013	2.0	2.0	n/a	n/a	0.032	n/a	n/a	n/a	19	14	n/a	n/a
	Edmonton Central	February 2009	0.4	0.012	2.2	n/a	n/a	n/a	0.030	n/a	n/a	n/a	n/a	5	n/a	n/a
semi-urban	Beverlodge	February 2009	n/a	0.033	n/a	n/a	n/a	0.001	0.005	n/a	n/a	n/a	n/a	2	n/a	n/a
	Henry Pirker	February 2009	0.3	0.020	2.3	n/a	n/a	0.001	0.017	n/a	n/a	n/a	n/a	4	n/a	n/a
Industrial	Mannix	February 2009	n/a	n/a	2.1	n/a	n/a	0.001	n/a	n/a	n/a	0.001	n/a	n/a	n/a	n/a
	Mildred Lake	February 2009	n/a	n/a	2.1	n/a	n/a	0.001	n/a	n/a	n/a	0.001	n/a	n/a	n/a	n/a

Notes:

bd – below detection limit **n/a** – parameter not monitored at this site ***** monitored for part of the study

ppm - parts per million **ng/m³** = nanograms per cubic meter **µg/m³** = micrograms per cubic meter

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Appendix B

The median concentration

The median concentration is a common way of representing the central value for environmental data. Most environmental data usually consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. For such data sets, the arithmetic mean will be biased by the high concentrations; the resulting value may not be representative of the central value for the data set. For example, a data distribution consisting of five numbers: 1, 2, 2, 3 and 10. The arithmetic mean of these data is 3.6 and the median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median is the middlemost value in the data set; thus more representative of the central value of the data distribution. Fifty percent of the values in the dataset are below the median and fifty percent are above.

Alberta's Ambient Air Quality Objectives

Alberta's Ambient Air Quality Objectives[1] are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta.
The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health. Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored by the MAML are listed in Table B1. Additional objectives can be found on the Alberta Environment's web site or through the department's information centre ((780) 427-2700).

Table B1: Alberta's Ambient Air Quality Objective and guideline measured by the MAML

Pollutant	One-hour AAAQO (ppm)	Basis
Ammonia	2	odour perception
Carbon monoxide	13	oxygen carrying capacity of blood
Nitrogen dioxide	0.212	odour perception
Ozone	0.082	reduction of lung function and effects on vegetation
Hydrogen sulphide	0.01	odour perception
Sulphur dioxide	0.172	pulmonary function
	One-hour AAAQO (ppm)	
PM$_{2.5}$	80	Canada Wide Standard

ppm - parts per million

[1] *Alberta Ambient Air Quality Objectives.* Alberta Environment. April 2005.

The Mobile Air Monitoring Laboratory (MAML)

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,
- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,
- an exhaust purifying system that minimizes emissions from the vehicle and
- two on-board generators that are also equipped with exhaust scrubbers

Table B2 lists the pollutants and meteorological data monitored by the MAML. Also indicated are the lower and upper detection limits for each monitored species.

Table B1: Alberta's Ambient Air Quality Objective and guideline measured by the MAML

Pollutant	One-hour AAAQO (ppm)	Basis
Ammonia	2	odour perception
Carbon monoxide	13	oxygen carrying capacity of blood
Nitrogen dioxide	0.212	odour perception
Ozone	0.082	reduction of lung function and effects on vegetation
Hydrogen sulphide	0.01	odour perception
Sulphur dioxide	0.172	pulmonary function
	One-hour AAAQG ($\mu g/m^3$)	
$PM_{2.5}$	80	Canada Wide Standard

ppm - parts per million

[1] *Alberta Ambient Air Quality Objectives.* Alberta Environment. April 2005.

The Mobile Air Monitoring Laboratory (MAML)

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,
- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,
- an exhaust purifying system that minimizes emissions from the vehicle and
- two on-board generators that are also equipped with exhaust scrubbers

Table B2 lists the pollutants and meteorological data monitored by the MAML. Also indicated are the lower and upper detection limits for each monitored species.

B 1: Alberta Environment's Mobile Air Monitoring Laboratory

Table B2: Pollutants and meteorological data monitoring by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	**Upper Detection Limit****
Ammonia (NH_3)	0.001 ppm	5 ppm
Ozone (O_3)	0.001 ppm	0.5 ppm
Carbon Monoxide (CO)	0.1 ppm	50 ppm
Hydrocarbons		
Methane (CH_4)	0.1 ppm	20 ppm
Reactive Hydrocarbons (RHC)	0.1 ppm	20 ppm
Total Hydrocarbons (THC)	0.1 ppm	20 ppm
Polycyclic Aromatic Hydrocarbons (PAH)	3 ng/m^3	1000 ng/m^3
Oxides of nitrogen		
Nitrogen dioxide (NO_2)	0.0006 ppm	1 ppm
Nitric Oxide (NO)	0.0006 ppm	1 ppm
Oxides of nitrogen (NO_x)	0.0006 ppm	1 ppm
Particulate Matter		
Total Suspended Particulates (TSP)	1 µg/m^3	1.0 g/m^3
Particulate Matter <10µm (PM_{10})	1 µg/m^3	1.0 g/m^3
Particulate Matter <2.5µm ($PM_{2.5}$)	1 µg/m^3	1.0 g/m^3
Sulphur Compounds		
Hydrogen Sulphide (H_2S)	0.001 ppm	1 ppm
Total Reduced Sulphur (TRS)	0.001 ppm	1 ppm
Sulphur Dioxide (SO_2)	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm - parts per million

ng/m^3 = nanograms per cubic meter

µg/m^3 = micrograms per cubic meter

g/m^3 = grams per cubic meter

* The ***lower detection limit*** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The ***upper detection limit*** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

Table B2: Pollutants and meteorological data monitoring by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	Upper Detection Limit**
Ammonia **(NH_3)**	0.001 ppm	5 ppm
Ozone **(O_3)**	0.001 ppm	0.5 ppm
Carbon Monoxide **(CO)**	0.1 ppm	50 ppm
Hydrocarbons		
Methane **(CH_4)**	0.1 ppm	20 ppm
Reactive Hydrocarbons **(RHC)**	0.1 ppm	20 ppm
Total Hydrocarbons **(THC)**	0.1 ppm	20 ppm
Polycyclic Aromatic Hydrocarbons **(PAH)**	3 ng/m^3	1000 ng/m^3
Oxides of nitrogen		
Nitrogen dioxide **(NO_2)**	0.0006 ppm	1 ppm
Nitric Oxide **(NO)**	0.0006 ppm	1 ppm
Oxides of nitrogen **(NO_x)**	0.0006 ppm	1 ppm
Particulate Matter		
Total Suspended Particulates **(TSP)**	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <10µm **(PM_{10})**	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <2.5µm **($PM_{2.5}$)**	1 $\mu g/m^3$	1.0 g/m^3
Sulphur Compounds		
Hydrogen Sulphide **(H_2S)**	0.001 ppm	1 ppm
Total Reduced Sulphur **(TRS)**	0.001 ppm	1 ppm
Sulphur Dioxide **(SO_2)**	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
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